SF 557
.048
Copy 1

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN No. 34.
B. T. GALLOWAY, *Chief of Bureau.*

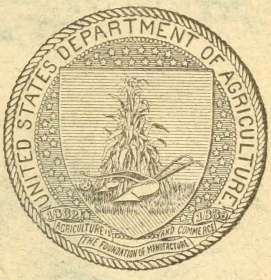
SILKWORM FOOD PLANTS:

CULTIVATION AND PROPAGATION.

BY

GEORGE W. OLIVER, EXPERT,
SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

ISSUED JANUARY 15, 1903.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

Monograph

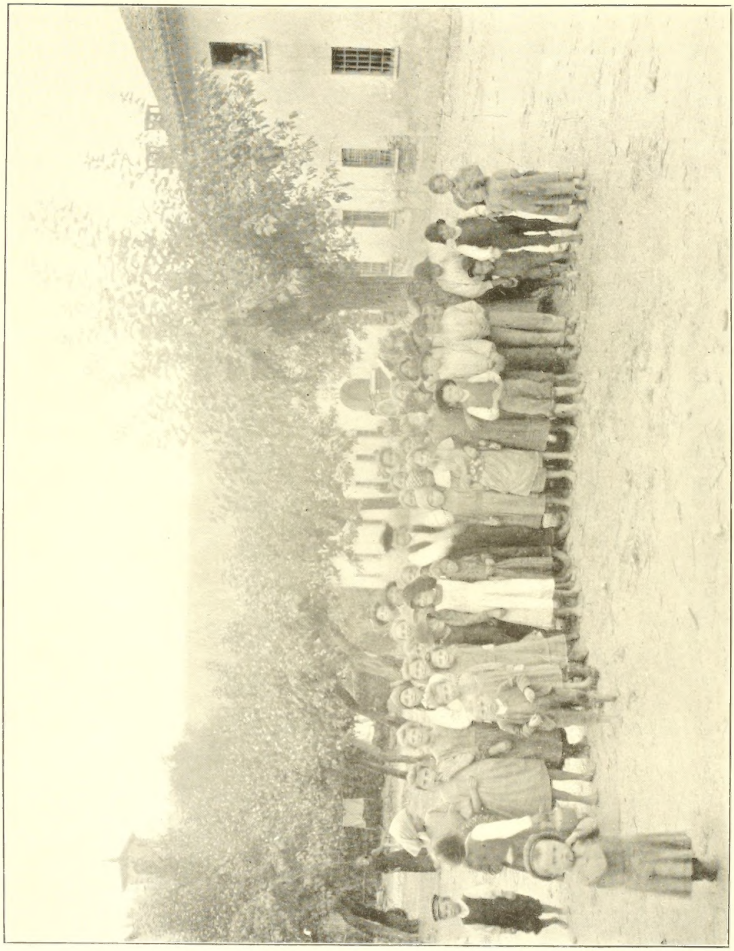
SHOUT
SHARE
IT

Class SF557

Book .048

35/382

533
96



MULBERRY TREES AND LEAF GATHERERS, LOMBARDY, ITALY.

Photographed August 26, 1902, by Dr. L. O. Howard.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN No. 34.
B. T. GALLOWAY, *Chief of Bureau.*

SILKWORM FOOD PLANTS:

CULTIVATION AND PROPAGATION.

BY

GEORGE W. OLIVER, EXPERT,
SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

ISSUED JANUARY 15, 1903.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

SF 557
.048

MAR 31 1908
D. of D.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., October 27, 1902.

Sir: I have the honor to transmit herewith a paper entitled "Silkworm Food Plants: Cultivation and Propagation," by George W. Oliver, Expert, Seed and Plant Introduction and Distribution, and respectfully recommend its publication as a bulletin of this Bureau.

The paper has been prepared at the request of Dr. L. O. Howard, under whose direction the funds appropriated at the last session of Congress for an investigation into the subject of silk culture in this country are expended. Dr. Howard has made a number of suggestions in regard to the scope and character of the paper, and has furnished the illustration used as a frontispiece, selected from a large number of photographs taken by him during the past summer while investigating the silk-cultural industry in Italy and other countries.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS

Page.

Introduction 7
Methods of reproduction 8
Propagation by cuttings 9
Summer cuttings 9
Winter cuttings 10
The cutting 10
Preparations for planting cuttings 10
Indoor spring cuttings 11
Propagation by seeds 11
Grafting and budding 12
Root grafting 13
Scion or sprig budding 14
Shield budding 15
Raising stocks for grafting and budding 16
Soil 16
Planting 16
Pruning 17
Description of plates 21

ILLUSTRATIONS.

Page.

Mulberry trees and leaf gatherers, Lombardy, Italy ..... Frontispiece.

PLATE I. Branch of the white mulberry, *Morus alba*, with large undivided leaves 20

II. Branch of the white mulberry, *Morus alba*, with divided leaves 20

III. An ornamental variety of mulberry, *Morus alba*, variety *venosa* 20

IV. Leaves of seedling Russian mulberry, *Morus alba*, variety *tatarica* 20

V. The native red mulberry, *Morus rubra* 20

VI. Paper mulberry, *Broussonetia papyrifera*. A.—Leaf from old tree. B.—Leaf from 2-year-old seedling. C.—Twig with female flowers. 20

VII. The Persian or black mulberry, *Morus nigra* 20

VIII. Osage orange, *Toxylon pomiferum*. Leaves, fruit, and bark 20

IX. Summer cuttings of the white mulberry, with leaves shortened 20

X. Winter cuttings of 1-year-old shoots of the white mulberry, ready for planting 20

XI. Root grafting the mulberry. A and B.—Scions fitted on stocks, ready to be tied. C.—Stock and scion wrapped and ready to be planted 20

XII. Scion or sprig budding. A and B.—Scions prepared for inserting. C.—Stock with bark raised, ready for scion. D.—Scion in position, ready to be wrapped. E.—Stock with scion held in place by wrapping. F.—Stock waxed to exclude air and moisture 20

SILKWORM FOOD PLANTS: CULTIVATION AND PROPAGATION.

INTRODUCTION.

There is a small family of plants closely allied to each other, a few of which supply the silkworm with food. This family is called *Moraceæ*. There are three genera of trees in the group—*Morus*, the mulberry (Pls. I, II, III, IV, V, and VII); *Toxylon*, the Osage orange (Pl. VIII), and *Broussonetia*, the paper mulberry (Pl. VI). The last named, being unsuitable for silkworm food, will not again be referred to here.

The Osage orange provides palatable food for the silkworm, and if the worms were free to select the leaves for themselves the tree would be satisfactory; but the leaves are selected for them often with bad results, for the young and immature leaves have a tendency to sicken the worms. Ignorance of this fact renders the use of the Osage orange dangerous.

Of the mulberry there are many so-called species and a great many varieties, but there are only one or two species and a few varieties which are of importance in silkworm propagation. Chief among these for producing silkworm food is the white mulberry, *Morus alba* (Pl. I). This is thought by some to be a native of China. It has long been known that the white mulberry and its varieties are hardy over a large area of the United States.

The uninitiated should not be left to their own devices in growing mulberry trees, especially if the enterprise is to be an extensive one, for if failure results, silkworm propagation in the particular section of the country where the experiment is conducted will receive a serious setback.

It is not the purpose of this paper to discuss the question of the most suitable varieties of the white mulberry, as this could only be done from a European point of view. Bureau, in his monograph, describes 27 varieties of the white mulberry alone. In Italy, silkworm growers favor *Morus alba*, variety *moretti*, and forms raised from it. France and Spain have each its favorite kinds. Japan has

close upon 100 forms, one or two of which would probably answer all purposes, while most of the silkworms reared in China are said to be fed upon *Morus multicaulis*. This mulberry was largely planted in the United States many years ago. Few, if any, of the original trees remain, but specimens which are thought to be wild seedlings of these are very plentiful in the Southern States. These trees are thoroughly acclimated and free from disease. It is therefore probable that there is now in the United States an abundant supply of material for propagating purposes, at least.

It is intended to show in these pages how the mulberry may be propagated and grown so as to provide the maximum amount of leaves for the food supply of the worms. The white mulberry, under good cultivation, is a low-growing tree, seldom attaining a greater height than 25 or 30 feet. It will reach this height in a comparatively few years after planting. Although it will live to a good old age, its growth, like that of most other trees, is most rapid when young. As the trees attain their full height they become stocky and make a multitude of small growths, from which flowers and fruit are produced. The fruit, which is usually abundant, is not a favorite in this country, being generally considered too sweet and insipid. In shape it may be said to resemble more or less that of an elongated blackberry. In the vicinity of Washington the trees flower about the middle of May and ripen their fruit during June.

METHODS OF REPRODUCTION.

The usual methods of propagation in use for fruit trees are employed with varying degrees of success in the case of the mulberry. These methods consist of budding, grafting, layering, cuttings, and seeds.

Grafting and budding are by far the most expensive methods, and it is doubtful if the results justify their use, so far as raising mulberry trees is concerned. Part of the work connected with budding and grafting consists in raising stocks, which are seldom large enough for use until they are two years old. At this age, the buds or grafts are inserted, and then troubles previously undreamed of present themselves to the inexperienced cultivator. Were the mulberry tree as easily managed so far as budding or grafting is concerned as is the peach, the use of these methods would be feasible, but unfortunately the mulberry is far from being an easy subject in this respect, and a few failures are apt to produce disappointment and disgust. It will frequently happen that old trees must either be removed or desirable varieties worked on them; budding or grafting may be resorted to in such cases.

Layering consists in bending down a portion of a branch so that its stem after being notched may take root in the ground while still attached to the parent tree. It is a cumbersome method, however.

Although good-sized plants can be raised in a short time by its use, it is seldom employed when any other method will produce the same results.

Raising young trees from cuttings of the 1-year-old ripened wood is a method which requires but little skill. As with budding and grafting, this method is instrumental in perpetuating varieties, as every rooted cutting will eventually be a reproduction of the tree from which it was taken. This is not the case with plants raised from seeds, which always vary considerably from the parent. For this reason some mulberry growers in Europe object to the seed method. Some of the seedlings, even from a single parent tree, will vary greatly in the value of the leaves for feeding purposes. Some will be thin in texture and lacking in the necessary chemical constituents; some, very hairy; others thick, smooth, and in every way desirable. However, experienced mulberry growers can readily tell the value of a seedling tree for feeding purposes, and it is therefore possible to make a selection in this respect without much loss.

PROPAGATION BY CUTTINGS.

SUMMER CUTTINGS.

In any group of seedlings there will always be found individuals the leaves of which possess great adaptability for feeding purposes. These should certainly be propagated to perpetuate this desirable characteristic. Propagation should be started after the seedlings have made considerable growth in order to insure a good supply of wood. These plants should be increased by cuttings during the summer months. At this season it is advisable to retain some of the leaves on the cutting and give treatment which will prevent shriveling during the process of rooting. The cuttings should be made from wood as ripe as possible; the leaves, besides being well matured, should be healthy and free from noxious insects. During July the lower parts of the current season's shoots will be found in good condition for propagating.

Trim the cuttings similarly to those shown in Pl. IX. At least two leaves shortened to one-half their length should be allowed to remain on the cutting. When placed in the propagating bed, the slips should be inserted in the sand in a direction sloping from the operator. Good results will follow if a cool propagating house is used, with clean sand as the rooting medium. When a propagating house is not available, a wide frame provided with sash will answer the purpose. The frame should face north, and if in the shade of trees, so much the better. The sash should be kept closed, so that a humid atmosphere may be maintained until the cuttings take root. After they have made a considerable quantity of roots in the sand they should be transferred

to beds in the open. The beds should be 5 feet wide. Place the rooted cuttings about 6 inches apart each way and water copiously until established, when they must be freely exposed to air and sunshine.

WINTER CUTTINGS.

The cutting.—The principal supply of plants may be secured by propagating from cuttings, which should be made from dormant wood taken from the trees just after the leaves have fallen.

In no case should the cutting wood be less in diameter than a quarter of an inch. The cuttings (Pl. X) should be about 10 inches in length, making the upper cut about one-half inch above a bud. The position of the lower cut is immaterial. The cuttings should now be tied in bundles of fifty and either stored for the winter or be immediately put out where they are to root. Where the winters are not too severe, or in the Eastern States south of the thirty-ninth parallel, they should be put in the ground during autumn. North of this it will be found best to keep them under cover until the ground is in a condition to be worked in early spring. If they are kept even for a short time in a dry place, they will lose their sap and become shriveled. Therefore they should be buried in moderately moist sand or sand and ashes. Under such conditions a good callus will have formed around the lower cut surface before the time arrives when they are to be put in the open. If sphagnum moss be easily procurable, it can be used very successfully as a substitute for sand or ashes; but in this case the bundles of cuttings should be smaller and they should be placed with the buds pointing upward, the moss to be packed tightly around them, with the top part uncovered. This is an excellent method for inducing the formation of a good callus.

Preparations for planting cuttings.—Previous to putting the cuttings in the open the soil should be plowed deeply, then harrowed and rolled until well pulverized. A furrow is made with a spade to a sufficient depth, a little sand placed in the bottom, and the lower ends of the cuttings placed on top. Fill in the soil to half the depth of the furrow, firm well with the feet, then fill in the remainder of the soil, leaving only enough of the cutting exposed to view to keep the top bud from being covered. Where there is danger of hard freezing weather after fall planting, cover the surface with rough stable litter or dead leaves, this covering to be removed before the buds begin to swell during the latter part of March.

The rows of cuttings can be arranged in beds of any convenient width, leaving spaces between the beds; this arrangement will facilitate covering, watering, and hand-weeding. If plenty of good ground is available, enough space should be left between the rows to permit of horse cultivation. During the summer the plants should be gone over several times and all superfluous shoots removed, leaving only

one shoot to each plant. If large enough, the rooted cuttings should be removed to nursery rows the following fall. In no case should the plants be removed from the cutting beds to permanent locations.

If the plants make sufficient growth the first season, they should be severely cut back; otherwise the operation should be deferred until the following season. The length of stem to remain as the future trunk must be regulated according to whether a dwarf or tall specimen is wanted. It must be taken into consideration that the leaves are much more easily gathered from dwarf trees than from tall ones; in fact, they are more easily managed, not only so far as leaf gathering is concerned, but also in pruning and in keeping noxious insects and fungus diseases under control. The leaves on a tall tree are not all developed alike; those on the side fully exposed to the sun will naturally be in perfect condition, while on the opposite side they are softer and probably not so well adapted to the purpose for which they are intended. Medium-sized trees are therefore preferable for all purposes.

INDOOR SPRING CUTTINGS.

Another method of propagation from cuttings, and a very successful one, consists in selecting medium-sized shoots about the beginning of November. These, before being made into cuttings, are sorted into bundles of different lengths, tied, and heeled in ashes or sand, or in a mixture of both, and protected by a frame having a northern exposure. During the winter they are taken out and cut into lengths of about 5 inches. These are tied in bundles and buried in moist sand or moss. In early spring they are untied and put quite thickly in a propagating bed having a mild bottom heat, where they will root rapidly. When such a bed is lacking, wooden flats about 4 inches deep may be used for the reception of the cuttings; but they must have the protection of a frame covered with sash. If a little loamy soil is placed in the bottom of the flats the cuttings will remain in good condition for a considerable time after rooting and until a favorable opportunity arrives for planting them out in nursery rows. If those rooted indoors are given plenty of air after being rooted in the bed, they can be transferred to the open ground with safety during dull weather.

PROPAGATION BY SEEDS.

The most convenient and rapid method of propagation is undoubtedly from seeds, as they are quick to germinate and the seedlings make growth about as rapidly as plants raised from cuttings. Seeds sown shortly after being harvested will germinate in a few days. If kept over winter and sown in early spring, the seedlings will appear within fourteen days. When the seed is spring sown, the seedlings will, if the weather be propitious, attain a height of from 12 to 18 inches in

one year; but during dry seasons they will only grow from 6 to 12 inches. Seedlings from seeds sown immediately after the fruit ripens are always small at the end of the season, but they produce strong plants the season following.

Seed is usually produced in great abundance by nearly all of the species and their varieties. The mulberry, like the strawberry, blackberry, and raspberry, does not ripen all of its fruit at one time; consequently several gatherings are necessary before a crop is harvested from any one tree. The earliest fruits can be gathered immediately after they are ripe and the seed sown if desired. It should be remembered that seedlings thus raised have comparatively little time to make their growth; therefore, every day counts.

In gathering the fruit, it will be found easiest to shake the tree and pick the fruits from the ground. To remove the seeds from the surrounding pulp, put the fruit into a large bucket or tub and squeeze with the hands until it becomes a jelly-like mass. Add water and stir well until the contents are thinned sufficiently to allow the seeds to sink to the bottom. The remaining material can be poured off. The seeds should be exposed to the air until dry. If it is desired to sprout them the same summer, they should be sown in beds in the open, the soil of which should previously be well worked by deep plowing and gone over several times with a harrow and a roller. When the soil is sufficiently pulverized the ground should be marked off into beds 5 feet wide and of any convenient length, leaving a space of 2 feet between the beds. To prevent washing of the soil and also to minimize the evil effects of drying winds, drive some stout stakes into the ground along the sides and ends of the beds, and to these nail eight or twelve-inch boards. The surface of the bed should be leveled and all stones and roots of plants removed with a hand rake.

Sow the seeds broadcast, taking care not to sow them too thick, as there is a danger of the seedlings crowding each other. Crowding produces weak plants, because even the best soil is capable of supporting only a certain number of plants to the square foot. Press the seeds into the soil with the back part of a spade and cover lightly with soil screened through a quarter-inch sieve.

In order to have the best results, the seed beds should not be exposed to the sun until a considerable time has elapsed after germination. This condition may be arranged as follows: Procure some pieces of 2 by 3-inch scantling; place two of the pieces parallel to each other $5\frac{1}{2}$ feet apart. Nail laths from one to the other, using the 2-inch surface in which to drive the nails. Leave 1-inch spaces between the laths. The slats are put lengthwise over the beds, and can be used with or without the side boards. Over the slats spread archangel mats, or canvas, until germination takes place; these coverings should be frequently dampened. After the seedlings show above the ground, the

cloth coverings are to be kept on during the hottest part of the day only, and when the first true leaf appears they may be removed altogether and the shade necessary thereafter supplied by the lath slats. Water must be supplied if the soil needs it. With spring-sown seed, the coverings over the lath slats may be dispensed with, but the surface of the bed should not be allowed to become dry until the seedlings are large enough to take care of themselves.

GRAFTING AND BUDDING.

In Italy and other silk-raising countries it is claimed that the leaves of trees raised from cuttings and seeds are superior for silk production, but that the quantity of leaves produced by trees so propagated is only about one-half the bulk of those from grafted or budded trees. Therefore, to produce a large quantity, grafting and budding methods of propagation are practiced to a great extent. Before the beginner undertakes these expensive methods of propagation in the United States, however, he should consider that land rentals are high in Europe and that land is cheap in the United States; therefore the American can afford to grow more trees by the methods which are instrumental in giving the best grades of silk. This is an important point to consider, and the writer is inclined to the belief that in the propagation of plants giving the highest grades of silk there will be little danger of a scarcity of material, as the mulberry thrives as well, if not better, in most parts of the United States as anywhere in Europe.

For those who decide to try propagating by grafting and budding two of the most successful methods of performing the operation are here described.

ROOT GRAFTING.

This is performed in February and March. The stocks, which are two-year-old seedlings of the Russian mulberry (*Morus alba*, variety *tatarica*), should show a diameter of at least three-eighths of an inch to give a satisfactory union. The stocks should be lifted in the fall and "heeled in" out of the reach of frost. The scions should be cut while in a dormant state and buried in damp sand in a protected place.

In the latter part of February the work of root grafting (Pl. XI) may be started. The preparatory work consists in securing a quantity of strong tidy cotton, and of grafting wax made of beeswax two parts, of resin two parts, and of mutton tallow one part. Put the ingredients in a small tin bucket, place on a hot stove, and when melted drop in one or more balls of the cotton, allowing them to remain in the melted wax for five minutes; remove with a pointed stick. When cool they are ready for use. Procure a deep box in which place the stocks, keeping them covered with a dampened sack; another box

should be provided for the scions similarly protected, and a third one for the grafted roots. These precautions are necessary, as a little exposure to dry air is always detrimental.

In beginning work with the stocks sever the top from the root at the collar; this can be done best with a pair of pruning shears. Take a scion at least 8 inches long and attach by the tongue method, as shown in Pl. XI. Select stocks and scions of as nearly the same diameter as possible; make a slanting cut at the bottom of the scion and a similar cut at the top of the stock. In the case of the scion, make an upward incision at a point about one-third of the length of the cut surface from the base; this will form a tongue. Next make a corresponding incision downward near the top of the slanting cut on the stock. The idea is to have the tongue of the scion take the place which the knife blade occupies when making the incision in the stock. When the two parts are neatly fitted so that the bark of stock and of scion come neatly together at one side, or at both if possible, bind firmly with the waxed cotton. This material should be used in preference to raffia, because when the grafted stock is buried in the ground, raffia would be certain to rot before the union took place, while cotton will remain in good condition for a long time.

After the fitting and tying have been done, the grafted stocks should be tied in bundles of twenty-five, the first tie to be made rather firmly near the upper part of the scions; secure them again near the base of the scions, but not as firmly as before. Care must be taken so as not to displace the fitted parts. The bundles should now be buried in sand in a frame or other protected place until planting time arrives. The grafted stocks should be planted out just as soon as the condition of the soil will permit. Plant them deep enough so that only the top bud is exposed to the light.

The subsequent treatment is in all respects similar to that given for cuttings. Mark the kinds, with the dates of grafting and planting, on large labels which will not be easily displaced.

SCION OR SPRIG BUDDING.

Scion or sprig budding, as shown in Pl. XII, is perhaps the most successful and easiest to accomplish of all methods. It is practiced on stocks which have not been transplanted for at least one year previous to the time when it is desired to bud. The stocks should be larger than those used for root grafting. The most desirable time for the operation is in spring, when the bark lifts easily; this will necessarily be after the stocks come into leaf. The scions must be selected from shoots of the previous season's growth, short and stocky, with two buds present (Pl. XII, A and B). They should be cut from the parent plants in the fall and kept dormant until the opportune moment arrives when the stock plants are in a receptive condition.

In preparing the stock for the scion the preliminary work is similar to that in shield budding the peach, cherry, or rose. At a point a little above the collar of the stock a transverse cut is made through the bark for a distance of half an inch or more around the stem (Pl. XII, C.) This is followed by a longitudinal cut, beginning in the middle of the first cut and extending downward for about an inch. Prize up the bark at each side of the long cut (Pl. XII, C) and it is ready for the scion, which is prepared for insertion by making an oblique cut through the base, so as to leave a cut surface about an inch long (Pl. XII, A and B). The scion is then fitted in place so that its cut surface is neatly placed against the wood of the stock (Pl. XII, D) laid bare by the raising of the bark. The next operation is shown in Pl. XII, E, and consists in tying the parts together so that they will be held firmly while the union is taking place. In order to exclude air and moisture, grafting wax or clay should be applied, as shown in Pl. XII, F.

Within two weeks from the time of budding, the union will be effected, if everything has gone well. The ligature should not be removed, however, until there is danger of its cutting into the bark. The most essential part of the subsequent treatment consists in heading back the stock, so that the future head of the tree will be formed by the growth of the scion, and to do this successfully good judgment must be exercised. Cut off only a part at first, leaving some foliage on the stock until the buds on the scion begin to push, when that part of the stock above the union should be removed with a sharp knife. Cover the wound thus made with grafting wax.

SHIELD BUDDING.

The shield system of budding may be used, but only in the spring, as the mulberry does not take kindly to shield buds inserted during the season suitable for most of our fruit trees.

Shield budding consists in selecting a stock, either a branch or stem, from which the bark slips readily. In raising the bark of the stock for the reception of the bud, the work is similar to that described for scion or sprig budding. The bud is usually selected from dormant wood kept over winter in ashes or sand; but for this there exists no necessity, because there is always present an abundance of dormant buds on a growing plant, and these answer the purpose much better than buds from dormant wood. To remove them, with a sharp knife make an incision in the stem about five-eighths of an inch below the bud; bring the blade up under the bud, severing a section of bark three-eighths of an inch in width, with the bud in the center; bring the blade out a little above the bud. If this operation is neatly performed the bud will require no further trimming before being inserted under the bark of the stock. The bark of the stock is then firmly bound over that of the bud and the parts kept in position with raffia. No

waxing is necessary. The union should take place within fifteen days, after which the ligature should be loosened or removed as proves necessary.

RAISING STOCKS FOR GRAFTING AND BUDDING.

In grafting and budding from any particular variety which it is desired to perpetuate, the Russian mulberry, *Morus alba*, variety *tatarica*, is the one used as stocks. It is of a robust-growing nature and has been found well adapted to the soils and climates of all the agricultural belts of the United States. It is this variety that is so much used in the West and Northwest for hedges, as it is the hardiest of all the mulberries.

Stocks are best raised from seeds, and a supply for this purpose should be obtained from a reliable source, to avoid unnecessary delay and disappointment. The sowing and the subsequent management of the seedlings are the same with stocks as with seedlings for general planting, except that when planted in nursery rows they should be placed about a foot apart, so as to give an abundance of space for the operator to work.

SOIL.

So far as has been ascertained, the mulberry is not particular as to the character of the soil. It seemingly grows equally well in a great variety of well-drained soils. Even in sandy and gravelly situations it holds its own. In shallow soils over hardpan the mulberry thrives after most of our fruit and ornamental trees have given up the struggle. Under the same conditions the Persian mulberry has been found to fruit abundantly.

Notwithstanding its behavior under what would be supposed adverse conditions, there are few plants which respond more vigorously to applications of manure. In Japan it has recently been shown that by liming alone the percentage of fiber in the leaves decreased very perceptibly. Again, by liming and also manuring with sodium nitrate and calcium sulphate a still further reduction in the fiber was apparent. The trees operated on were 1½ meters (5 feet) high. Each tree was treated with 500 grams (1.1 lbs.) of lime, 400 grams (.9 lb.) of sodium nitrate, and 200 grams (.44 lb.) of calcium sulphate. How the caterpillars fared as a result of this change in the composition of the leaves is not stated.

PLANTING.

This all-important operation may be performed either in the fall or spring. After the leaves have fallen or are matured, no delay should occur in transplanting to permanent positions. When this period is selected, it gives good opportunities for the formation of new roots.

In spring the trees may be transplanted any time after the ground is in a workable condition and up to the period when the buds are about to burst into growth. Spaces intended to be planted should be deeply worked beforehand by plowing and harrowing, and after planting the weeds should be kept down.

The distance between the trees should not be less than 10 feet in the rows, and the rows should be the same distance apart. If the field devoted to the trees is more than 2 or 3 acres in extent, wider spaces should be left at intervals for wagons, etc. It is certain that trees planted 10 feet apart will eventually occupy all the space; but when there is danger of their becoming too much crowded, enough of the plants may be rooted out and burned to allow the remainder abundant space to develop. If this is done, those which are to remain permanently should be trained accordingly. The above arrangement is the best for trees nearly all the branches of which can be reached from the ground, not only for pruning, but also for leaf gathering.

In planting trees similar precautions should be taken to those in the case of ordinary forest trees; that is, not to allow the roots to become in the least dry from the time they are lifted from the nursery rows until planted in the field. As soon as they are lifted the roots should be dipped in a mixture of soil and water and kept covered until planted, so that they will not become dry. If the ground is naturally hard and the soil is poor, dig large holes, even for very young trees, as they grow rapidly and should be encouraged to make good, stout growths from the beginning. Put some good soil in the hole, spread out the roots on this, and cover with several inches of fine soil before firming with the feet. Allow the roots to be about the same depth in the hole as they were in the nursery rows. Prune back the growth of young trees one-half in the fall, and if necessary cut back to strong buds in early spring.

PRUNING.

The pruning of the trees presents no special difficulties so long as it is done early enough in the season to avoid late growth, which, if caught by cold weather before ripening, will perish during the winter. The principal pruning should be done in winter and should consist of shortening back strong growths so as to form a low, spreading tree. Keep the central part of the tree as free of growth as possible, to admit light and air.

After the first cutting back, select three or more of the strong shoots to form the principal branches. If they are strong and show a disposition to grow upright, they may be kept apart by using three sticks tied in the shape of a triangle; place these in the center of the tree and tie the branches to them until they grow in the desired

direction. By careful attention to cutting out the undesirable growths the tree can be made to assume any desired shape.

In gathering the leaves always allow enough to remain on the tree to insure its perfect health. If some of the trees show signs of failing vigor as a result of excessive leaf gathering, it is advisable to allow them to grow for a season without picking, and by early pruning out of unnecessary growth permit those growths which are desirable to become ripened.

PLATES.

DESCRIPTION OF PLATES.

FRONTISPIECE.—Old mulberry trees, showing Italian method of pruning, with a group of embryo silk culturists (leaf gatherers) in the foreground, Lombardy, Italy. By this method of pruning, tall trunks from 8 to 10 feet from the ground are produced, necessitating the use of ladders for leaf gathering. From a photograph taken August 26, 1902, by Dr. L. O. Howard.

PLATE I. Branch of the white mulberry, *Morus alba*, with large undivided leaves, of thick texture and smooth surface. The leaves of this variety are preeminently adapted for silkworm food. From photograph of a tree in the grounds of the U. S. Department of Agriculture.

II. Branch of seedling white mulberry, *Morus alba*, with divided leaves. Seedlings from the same parent will sometimes have leaves of the divided form, others assuming the undivided shape shown in Plate I, while some may have both forms on the same tree.

III. An ornamental variety of mulberry, *Morus alba*, variety *venosa*. Of no value as food for silkworms.

IV. Leaves of seedling Russian mulberry, *Morus alba*, variety *tatarica*. This mulberry, owing to its extreme hardiness, is used for stocks on which to graft or bud the most valuable varieties in order to perpetuate their characteristics, propagation from seed being altogether unreliable for perpetuating varieties.

V. The native red mulberry, *Morus rubra*. From a specimen in the Herbarium of the U. S. National Museum. The varieties of this species are usually prized for their fruits, being of little value as food for silkworms.

VI. Paper mulberry, *Broussonetia papyrifera*. Valueless in silk culture. A.—Leaf from old tree. B.—Leaf from 2-year-old seedling. C.—Twig with female flowers.

VII. The Persian or black mulberry, *Morus nigra*. This species is cultivated in Europe and Asia for its fruit. From photograph of a tree in the grounds of the U. S. Department of Agriculture.

VIII. Osage orange, *Toxylon pomiferum*. Leaves, fruit, and bark. The mature leaves of this native tree provide excellent food for silkworms.

IX. Summer cuttings of the white mulberry, with leaves shortened to prevent excessive evaporation.

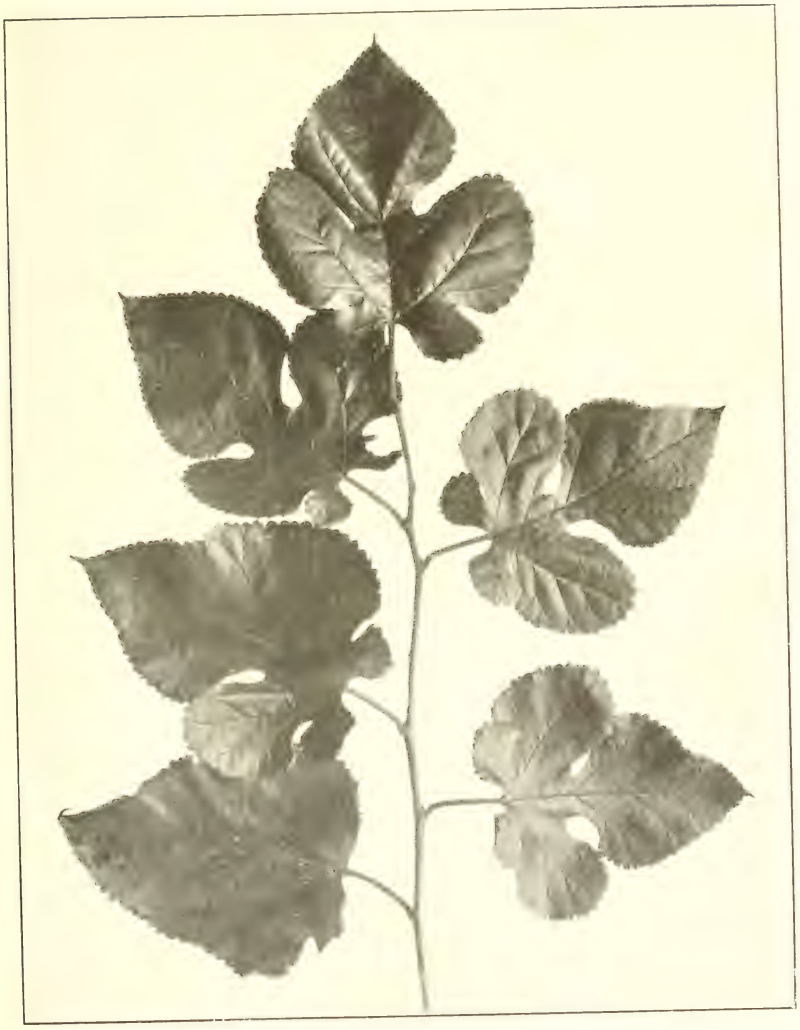
X. Winter cuttings of 1-year old shoots of white mulberry, ready for planting.

XI. Root grafting the mulberry. A and B.—Scions fitted on stocks, ready to be tied. C.—Stock and scion wrapped and ready to be planted.

XII. Scion or sprig budding. This method of propagation can be used on strong seedling stocks or on branches of trees. A and B.—Scions prepared for inserting. C.—Stock with bark raised, ready for scion. D.—Scion in position, ready to be wrapped. E.—Stock with scion held in place by wrapping. F.—Stock waxed to exclude air and moisture.

O

BRANCH OF WHITE MULBERRY (MORUS ALBA), WITH LARGE UNDIVIDED LEAVES.



BRANCH OF WHITE MULBERRY (MORUS ALBA), WITH DIVIDED LEAVES.

BRANCH OF WHITE MULBERRY (MORUS ALBA), VARIETY VENOSA.

LEAVES OF SEEDLING RUSSIAN MULBERRY (MORUS ALBA), VARIETY TATARICA.

BRANCH OF THE NATIVE RED MULBERRY (MORUS RUBRA).

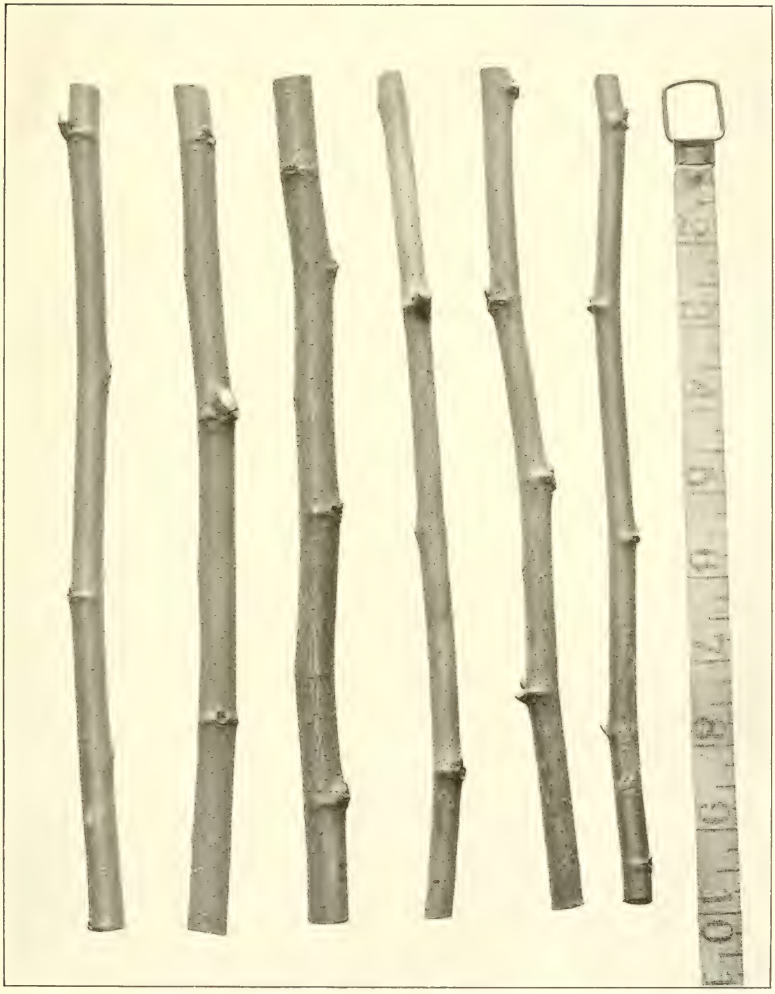
PAPER MULBERRY (BROUSSONETIA PAPYRIFERA).

A, Leaf from old tree; B, leaf from two-year-old seedling; C, twig with female flowers.

BRANCH OF THE PERSIAN OR BLACK MULBERRY (MORUS NIGRA).

LEAVES, FRUIT, AND BARK OF THE OSAGE ORANGE (TOXYLON POMIFERUM).

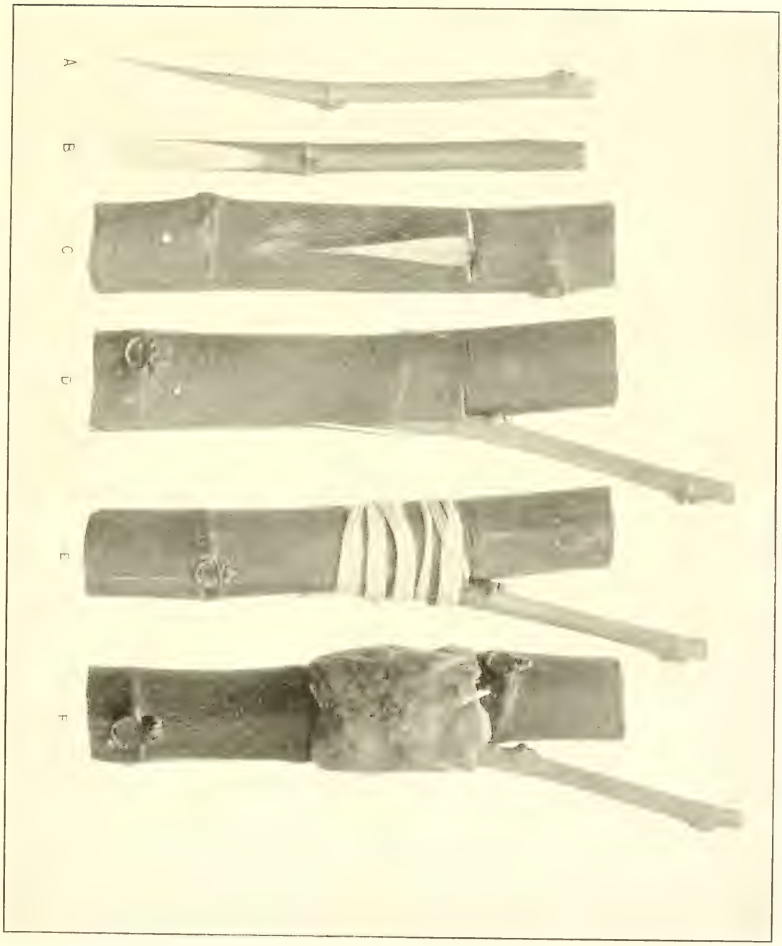
SUMMER CUTTINGS OF WHITE MULBERRY, WITH LEAVES SHORTENED.



WINTER CUTTINGS OF ONE-YEAR-OLD SHOOTS OF WHITE MULBERRY, READY FOR PLANTING.

ROOT GRAFTING THE MULBERRY.

A and B, scions fitted on stocks, ready to be tied; C, stock and scion wrapped and ready to be planted.



SCION OR SPRIG BUDDING.

A and B, scions prepared for inserting; C, stock with bark raised; D, scion ready to be wrapped; E, scion wrapped; F, stock waxed.

LIBRARY OF CONGRESS
0 002 849 355 1